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On the Morning of Sunday, the 20th inst., at his residence, Rede Hall, Burstow, Surrey,

WALTER WELDON, F.R.S.,

Chevalier of the Legion of Honour,

FORMERLY PRESIDENT OF THE SOCIETY OF CHEMICAL INDUSTRY,

Vice-President of the Chemical Society and of the Institute of Chemistry,

DEPARTED THIS LIFE IN THE 53RD YEAR OF HIS AGE.

A LOSS DEEPLY REGRETTED BY MANY FRIENDS AND COLLEAGUES.

INTERNATIONAL INVENTIONS EXHIBITION, LONDON.

REPORT ON THE EXHIBITS RELATING TO THE CHEMICAL INDUSTRIES.

BY WATSON SMITH,
Lecturer in Chemical Technology in the Victoria University, Manchester, etc.

(Continued from page 483.)

COLOURING MATTERS AND DYES.

Robert Chadwick & Son, of Kidderminster (*Group XIV. No.* 1462).

(1.) Improvement in extracting colouring matter and other substances by steam-process from dyewoods; also distillation of ammonia.

(2.) Hygienic crystals and powder disinfectant.

ACIDS, ALKALIS, AND SALTS.

E. C. C. Stanford's New Method of Treating Seaweed (*Group XIV. No.* 1431).

Mr. Stanford's name is intimately associated with the British iodine and kelp industry, the seat of which has always been in Glasgow. The exhibit illustrates generally the manufacture of iodine, bromine, and potassium salts from seaweed, besides that of the new and interesting substance *Algin*, first isolated and studied by Mr. Stanford; also many of the metallic alginates. It would appear that amongst seaweeds, the algæ possess the power of assimilating the iodine from seawater to about ten times the extent of the bromine, and that amongst the algæ the Laminaria and the Fuci are the kelp-producing species of the genus referred to. It is remarkable that the three gelatinous species, Chondrus, Gilideun, and Euchemia contain little or no iodine; moreover, the Enteromorpha or sea-grass, a plant retaining, when dry, a very strong odour of the sea, contains no iodine. The giant algæ growing outside the influence of the Gulf Stream, generally supposed to be the iodine-carrier, singularly enough contain very little iodine. The drift-kelp is made from two varieties of red weeds, or Laminaria, the *L. Digitata* and the *L. Stenophylla.* The former is known as tangle, and both kinds are always submerged. These seaweeds, and especially the latter, are much injured by rain, and are often, after drying, almost valueless. If well preserved, the Laminaria contain ten times as much iodine as the Fuci. It furnishes the only kelp now used for making iodine. The usual yield of kelp from 100 tons of wet seaweed is five tons, and as only half of this is soluble, two-and-a-half tons form the total valuable product of what may be termed the *native process*, and this must pay for the labour of cutting, carrying, drying, and burning 100 tons of wet seaweed. As the people in burning the weed use such a heat as to produce a sort of slaggy mass, and lose thereby about half the iodine, Mr. Stanford proposed the so-called *Char-process*, by which all the iodine is saved. The weed in this process is submitted to destructive distillation in iron-retorts, leaving behind a loose, porous charcoal, retaining the salts and the iodine, and yielding in the distillate, ammonia, acetic acid, and tar. In a still newer process—in fact, the one referred to in the title of the exhibit—Mr. Stanford extracts first the potassium chloride ("muriates"), potassium sulphate and "kelp-salt" (sodium chloride containing some carbonate and including the iodides), by simple maceration in cold water. The amount so removed from air-dried Laminaria is about one-third of its weight (thirty three per cent.), of which twenty to twenty-two per cent. are mineral salts, and the balance consists of dextrin, mannite, and extractive matter, leaving two-thirds of the plant (sixty-six per cent.) for further treatment, apparently unaltered. This residue contains the peculiar new substance *Algin*, and the cellulose. The comparison between the three processes is of considerable interest, as showing the advance made upon the old kelp process so tenaciously adhered to and persisted in by the West Coast natives, by Mr. Stanford's "Char" and "Wet" processes:—

KELP PROCESS.

Per cent. utilised, 18.

Kelp, 18 tons	Salts, 9 tons Iodine, 270lb.	Residuals—Kelp-waste, 18 tons, valueless.

CHAR PROCESS.

Per cent. utilised, 36.

Char, 36 tons	Salts, 15 tons Iodine, 600lb.	Residuals—Charcoal, 36 tons, tar and ammonia.

WET PROCESS.

Per cent. utilised, 70.

Water extract, 33 tons	Salts, 20 tons Iodine, 600lb.	Residuals—Algin, 20 tons, cellulose, 15 tons, dextrin, etc.

In this new process, the seaweed is to be exported and worked at a central factory, and all the common varieties can be used. The weed is first boiled with sodium carbonate, the solution is filtered and precipitated with sulphuric acid, the precipitate being the new substance algin, which resembles albumen, and contains all the nitrogen, and, moreover, all that is nutritive in seaweed. The solution is now neutralised with limestone, the sulphate of lime deposited, the neutral solution evaporated down and the sulphate of soda crystallised out. The mother-liquor, containing all the potash salts and iodine, is carbonised, forming the "kelp-substitute." The residue on the filter is the cellulose. The whole plant is thus utilised (see table above).

RESIDUE.	SODA SOLUTION.		
	Precipitated by Sulphuric Acid.	Retained in Solution.	
Cellulose.	Algin.	Sulphate of Soda, crystallised out as Glauber's Salts.	Mother-liquor, carbonised, is Kelp-substitute.

Algin has fourteen times the viscosity of starch, and thirty-seven times that of gum-arabic. Algin or sodium alginate in solution is precipitated or coagulated by alcohol, acetone, and collodion, but not by ether. It is precipitated by mineral acids, various salts, and by lime- and baryta-water. The solution is not precipitated or coagulated by alkalis and alkaline salts, starch, glycerol, and cane-sugar. It does not precipitate the ordinary alkaloids. It is distinguished from albumen, which it most resembles, by not coagulating on heating, and from gelose by not gelatinising on cooling, by containing nitrogen, by dissolving in weak alkaline solution, and being insoluble in boiling water. From gelatin it is distinguished by giving no reaction with tannin; from starch, by giving no colour with iodine; from dextrin, gum-arabic, tragacanth, and pectin, by its insolubility in dilute alcohol and dilute mineral acids.

It is remarkable that it precipitates the salts of the alkaline earths, with the exception of magnesium, and also most of the metals, but it gives no precipitate with mercuric chloride or potassium silicate.

Commercial Applications of Algin or Sodium Alginate :—

For Sizing Fabrics.—As a finish, algin has the advantage over starch that it fills the cloth better, is tougher and more elastic, that it is transparent when dry, and that it is not acted on by acids. It imparts to the goods a thick clothy, elastic feeling, without the stiffness imparted by starch. It has the advantage, possessed by no other gum, of becoming insoluble in presence of a dilute acid, which decomposes starch or dextrin. No other gum having anything like the viscosity of algin, in solution, none will go so far in making up the solution or cover such a large surface.

The alginate of alumina in caustic soda, is a stiff dressing, and in the crude, unbleached state, will be a cheap dressing for dark materials; and in the colourless for finer fabrics. *The ammoniated alginate of alumina* can be used to give a glossy surface, which is quite insoluble after drying.

As a Mordant and Dung-substitute in Dyeing and Printing.—Mr. John Christie, of the firm of J. Orr Ewing & Co., states that "there is another application of the alginate of soda—viz., in the fixing of mordants, such as those of alumina or iron upon cotton fibre." Very encouraging results are said to have been obtained, and Mr. Christie believes a very large application will be found for alginate of soda as a "*dung-substitute.*" This being the case, the substitution of so harmless a compound for one so poisonous as the generally used arseniate of soda, should be welcomed, and a fair trial be accorded the new dung-substitute. In Germany, where the use of poisonous materials in connection with printing and dyeing textile fabrics is greatly restricted, if not altogether interdicted, one would imagine such a substitute would, when known, be readily adopted. Mr. Christie continues, "The mordants, when precipitated, seem to have full dyeing power," which means that as a dung-substitute the alginate has done its work well.

As an Article of Food.—Algin contains—carbon, 44·39 per cent.; hydrogen, 5·47; nitrogen, 3·77; oxygen, 46·57, or about the same amount of nitrogen as is found in Dutch cheese. For thickening soups and puddings, as a substitute for gum-arabic in the manufacture of jujubes and lozenges, in making jellies, it is said that it would be very serviceable.

In Pharmacy.—It is said that it would be useful for emulsion of oils, as an excipient for pills, and for fining of spirits.

For Boiler Incrustations.—Mr. Spiller has proved that a solution of sodium alginate forms one of the best fluids for preventing boiler-incrustation, as it quickly precipitates the lime from the boiler water in a state in which it can be easily blown off.

Algic Cellulose :—This substance bleaches easily, and under pressure becomes very hard, when it can be turned and polished with facility. It makes also a good paper, tough and transparent, but with no fibre. Alone or mixed with algin and linseed oil or shellac, it may be used as a non-conductor of electricity, where a cheap material is required.

The Seaweed Charcoal :—It is proposed to use this in conjunction with algin for covering boilers, and such a composition has been largely applied under the name of "carbon cement." This is nearly all charcoal, three per cent. of the algin being sufficient to make it cohere. It forms a cool, light, and efficient non-conducting covering.

The foregoing details have been given somewhat *in extensô*, but the subject is one of those for which the claim of *national importance* can be set up.

Mr. Stanford says, in his paper read before the Society of Arts (May 22, 1884): "No Royal Commission will give the crofters and cottars on the shores of the Hebrides and the West of Ireland anything like the satisfaction that the offer of £1 per ton for all the seaweed they could gather, would. In all these places, the sea-question might soon become more important than the land-question."

The advantages to Proprietors of Shores are that such manufacture would afford an export value to a large waste product at present almost worthless. The export of this bulky material must result in a large traffic to and from the Western Islands, thus improving their rental and value, and assisting in imports of coal, meal, etc.

For Alkali Makers there would also be advantages in such a new manufacture, creating, as it would, a large demand for alkali, bleach, and other chemicals, with some waste products.

Mr. Stanford's process is protected by the following patents:—Eng. Pats. 142, January 12, 1881; and 13,433, October 11, 1884. Also by French Pat. 143,736, July 1, 1881.

The process has been working some time on a semi-industrial scale; all difficulties are successfully overcome, and already there is a considerable demand for the new products.

The following is a list of the more interesting specimens exhibited by Mr. Stanford :—

ALGINATES.

Sodium	Alginate,	Soluble	
Potassium	,,	,,	
Ammonium	,,	,,	
Lithium	,,	,,	
Magnesium	,,	,,	*(This is a remarkable body; insoluble alginic acid in the presence of water, freely dissolves Magnesia and its carbonate.)*
Calcium	Alginate,	Insoluble	
Barium	,,	,,	
Strontium	,,	,,	
Lead	,,	,,	
Silver	,,	,,	
Mercury	,,	,,	*Mercurous salt, no Mercuric alginate.*
Copper	,,	,,	
Iron	(Ferrous)	,,	
,,	(Ferric)	,,	
Cobalt	,,	,,	
Nickel	,,	,,	
Manganese	,,	,,	

ALGINATES—*Insoluble.*

Tin	Alginate,	Stannic	
,,	,,	Stannous	
Zinc	,,		*(Most of the alginates have not yet been described, and the exact composition is unknown.)*
Chromium	,,		
Cadmium	,,		
Bismuth	,,		
Aluminium	,,		
Platinum	,,		
Arsenic	,,		
Antimony	,,		
Uranium	,,		

The following salts are double alginates of the metals with ammonia, and are all very soluble, mostly becoming insoluble when dry, thus forming waterproofing materials:—

Ammonium,	Strontium	Alginate	
,,	Chromium	,,	
,,	Copper	,,	
,,	Iron	,,	Ferric
,,	,,	,,	Ferrous
,,	Tin	,,	Stannic
,,	,,	,,	Stannous
,,	Cobalt	,,	
,,	Nickel	,,	
,,	Manganese	,,	
,,	Silver	,,	
,,	Platinum	,,	
,,	Zinc	,,	
,,	Cadmium	,,	
,,	Aluminium	,,	
,,	Uranium	,,	
,,	Arsenic	,,	
,,	Antimony	,,	

The Aluminium Alginate is also shown in combination with Aluminate of Soda, making a cheap stiff soluble dressing for cotton and other goods, which can be easily rendered insoluble.

Shellac Algin.—Shellac combines with Sodium Alginate, and with Ammonium Alginate, forming a soluble compound of great flexibility; by dipping the sheets of it in a dilute acid or chloride of calcium, these are rendered insoluble, and form a tough membrane resembling gutta-percha, and a good electric insulator.

Calcium Alginate.—A dried block of this substance is exhibited to show its use for ornamental purposes. The sp. gr. is about 1·6, approaching that of ivory.

Insoluble Algin, or Alginic Acid, has a sp. gr. of 1·5, and closely resembles horn.

Algic Cellulose.—A block of this is shown on account of its value for turning purposes; the sp. gr. is about 1·4; higher than that of ebony or lignum vitæ.

Algic Boiler Fluid.—(Already referred to.)

Carbon Closet System.—(See *Chemical News*, vol. xxix. 201 and 284.) A series of specimens is shown to illustrate the application of charcoal to this purpose. The method has been in use for many years in some of the largest shipyards on the Clyde, and has given great satisfaction.

Sewage Filtration.—The specimens shown are historical, having been first exhibited in the Paris Exhibition, 1867.

Specimens.	Percentages of SO_3	Specific Gravity.	Remarks.
—	8·3	1·852 at 60° F. (15·5° C.)	—
Liquid.	30·0	1·910 ,, ,,	—
Crystalline mass resembling nitre.	40·0	1·970 ,, ,,	= 1·956 at 80° F. (26°·6 C.) from which the sp. gr. at 60° F. was calculated.
	41·5	1·975 ,, ,,	
	46·2	1·977 ,, ,,	—
—	59·1	1·991 ,, ,,	—
Liquid.	60·8	2·006 ,, ,,	—
	65·0	2·006 ,, ,,	—
	69·4	2·016 ,, ,,	—
Crystallised.	72·8	1·998 ,, ,,	= 1·980 at 87° F.
	80·0	1·973 ,, ,,	= 1·957 at 81° F.
	82·0	1·937 ,, ,,	—

Messrs. Chapman & Messel (*Group XIV. No.* 1467).

MANUFACTURE OF ANHYDROUS SULPHURIC ACID.

This firm exhibits fine specimens of sulphuric anhydride, which is manufactured on a large scale now with the greatest ease, in the Silvertown works of the firm—thanks to the improvements which were the outcome of the investigations and engineering skill of Drs. W. S. Squire and R. Messel.

Specimens of sulphuryl-monochlorhydrin,

$$SO_2(Cl)OH,$$

and of finely-crystallised 100 per cent. sulphuric anhydride, are exhibited; also a drum made of wrought-iron plate, for packing and carrying the anhydride, is to be seen underneath the show-case. The charging hole of the drum is secured by a kind of screw-stopper, fitting by an appliance known as the bayonet-joint—a simple but powerful means of closing.

Dr. Messel has kindly supplied the writer with some details which are of great interest both for chemist and physicist.

Kohlrausch (*Pogg. Ann. Ergänzungsband*, viii. p. 675) shows that the real hydrate, SO_4H_2, does not present the maximum density of sulphuric acid, as all the tables published had formerly stated, but that water cautiously dropped on the surface of really pure hydrate forms slowly-sinking drops. He found the densities of concentrated acid at 18° C. (water at 4° C. = 1) were:—

Percentage by weight of SO_4H_2.	Specific gravity.
90	1·8147
91	1·8200
92	1·8249
93	1·8290
94	1·8325
95	1·8352
96	1·8372
97	1·8383
98	1·8386
99	*1·8376*
100	*1·8342*

It will thus be seen in the above table that after exceeding the strength of 98 per cent. of SO_4H_2, the acid becomes lower in specific gravity as it further rises in strength to 100 per cent. of SO_4H_2. It has been found by Dr. Messel that an analogous law holds good with regard to solutions of sulphuric anhydride in monohydrated sulphuric acid (SO_4H_2), and that whereas solutions of SO_3 in SO_4H_2, as they increase in percentage of SO_3, likewise increase in specific gravity up to a certain point, after passing that point and attaining a still higher percentage strength in the nearer approach to the condition of the pure anhydride itself, they do not now increase, but diminish in density.

Dr. Messel reserves to himself the right to pursue the investigation, and to repeat his experiments with more stringent scientific exactitude, using absolutely pure materials, so as to gain numbers, doubtless nearly, though perhaps not quite, identical with those hereinafter given.

It will be observed in the exhibit that the specimen cylinders are arranged in a special order, and this the table on previous page will explain, and at the same time the interesting development of a law analogous to Kohlrausch's, will manifest itself.

The 100 per cent. anhydride is crystallised in fine feathery needles. It has been stated that this mode of crystallising is caused by the presence of a trace of water (SO_4H_2), without which it would crystallise like nitre. This, however, needs confirmation. It will be observed in the above table that we have a 30% liquid body, then 40 to 46% crystallised bodies; and at 60 to 69% we have again liquids, a crystalline stage being again and finally reached at 72·8% of SO_3.

Sulphuryl-chlorhydrin, $SO_2Cl(OH)$. — Sulphuric anhydride used for sulphonating organic substances requiring strong treatment, would act too powerfully, and the sudden change of state from the anhydride in the liquefied or fused form to solid sulphonate, in addition to the result of the sudden chemical reaction, causes such a sudden and violent evolution of heat that a considerable portion of the substance is charred. It has been found that by using sulphuryl-chlorhydrin, this tendency to char is prevented, and thus larger yields of sulphonates are obtained, and, moreover, that by its use only one compound is formed, and no isomerides, which is usually not the case when anhydrides are used. The action taking place may be thus explained :—Sulphuryl-mono-chlorhydrin acts on an organic substance capable of yielding sulphonates in such a manner, that whilst sulphonate is formed, hydrochloric acid is simultaneously evolved, and the change of state from $SO_2<^{OH}_{Cl}$ to $SO_3 \mid HCl$, means that the elements of HCl in a liquid substance suddenly unite to form a gas (HCl), heat thus becoming latent. Thus, a large portion of the heat suddenly evolved by the reaction of the SO_3, on the substance sulphonated on the one hand, is simultaneously absorbed in the formation of gaseous hydrochloric acid on the other. This signifies, of course, a kind of cooling process which prevents charring, and so contributes to a larger yield of the sulphonic acid.

Mode of Analysing Specimens of Sulphuric Anhydride.—Two stoppered bottles, containing bulb tubes, with their extremities open and bent in opposite directions, are shown, and these refer to the method adopted by Dr. Messel as the safest and best for easily obtaining in aqueous solution weighed quantities of samples of anhydrides for analysis. A third bottle stoppered up, and containing water along with the sealed bulb of anhydride, illustrates the stage of the operation when a brisk shake is required to break the bulb, the SO_3 going at once into solution in the water.

Fig. 1 represents the bulb tube with extremities bent in opposite directions. Fig. 2 shows the weighed bulb in position for filling itself to any given mark or point in the upper stem, from a bottle containing the anhydride specimen. The bent limb, projecting above the neck of the bottle, is then conveniently situated for closing with the blow-pipe flame. After closing in this manner, the bulb is withdrawn, whilst the extremity is *still warm*, and thus no anhydride can be forced out at the opposite and previously submerged extremity, as the fingers will be cooler than the place touched in the withdrawal from the bottle. Having reversed the position of the extremities of the bulb, the other limb is in like manner closed with the blow-pipe flame, when after cleansing and wiping dry, the bulb is weighed again. It is next cautiously inserted in the bottle (Fig. 3), and gently induced to take the position indicated, some pure water being introduced about the level shown in the cut. The stopper is then adjusted, and the bottle being taken in the hand is so held that the former is firmly kept in its place. One vigorous shake now suffices to break the bulb in the bottle, and in this there is no danger, only a sudden vibration being felt at the instant the anhydride comes in contact with the water. A white cloud is observed on the sides of the bottle, but by a few gentle shakes a perfect solution is obtained, and after allowing the bottle to cool, it may be opened and the analysis at once commenced. First SO_2, always present to some extent, is determined by titration with iodine solution, and then the SO_3 after precipitation as barium sulphate, though as a rule volumetrically.

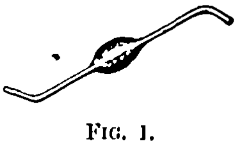

FIG. 1.

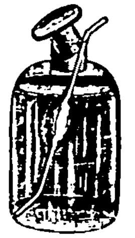

FIG. 2.

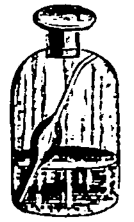

FIG. 3.

A. BOAKE & Co., LONDON (*Group XIV. No.* 1467).

This firm exhibits a complete collection of products connected with the sulphurous acid industry. Liquefied sulphurous anhydride is a speciality of the firm, and in the glass syphons arranged to deliver either the liquid or gaseous acid as desired, it forms a most convenient preparation for the use of the chemist or photographer. For use in ice-making, brewing, paper-making, disinfecting, bleaching, etc., liquefied sulphurous anhydride is also exhibited in copper drums, containing 1 and 2 cwt. respectively. A very complete set of sulphites is exhibited, many of these being but little known, and some entirely new. Amongst these sulphites the following specimens deserve special notice :—

Sodium sesqui-sulphite, $Na_4(SO_3)_3.9H_2O$. Fine white needles.

Chromium sulphite, $Cr_2.3SO_3$. Beautiful transparent green crystalline mass.

Cuproso-cupric sulphite, $Cu_2SO_3,CuSO_3,2H_2O$. Mass of glistening small needles, of a rich brown colour.

Ammonium sulphite, $(NH_4)_2SO_3$. White prisms.

Lithium sulphite.

Uranium sulphite, $Ur_2,3SO_3$. Beautiful orange yellow crystalline mass.

Nickel sulphite, $NiSO_3.6Aq$. Fine green tetra-hedra.

A new salt, meta-sulphite of potassium, is exhibited in the form of fine large and sharply-defined crystals. It will probably find considerable application in the arts, seeing that it contains nearly 60 per cent. of SO_2, and is at the same time perfectly stable, neither oxidising nor evolving sulphur dioxide on exposure in the air. The ammonio-cuproso sulphite is a singular copper salt, being perfectly white, and crystallising in small white pyramids.

The sulphites at present of greatest industrial value are well represented by sodium sulphite, crystallised and anhydrous; bisulphite of sodium, solid and in solution, sulphite and bisulphite of magnesium, and sulphite and bisulphite of calcium.

JAMES HARGREAVES, WIDNES (*Group XIV. No.* 1467).

HARGREAVES AND ROBINSON'S PATENT PROCESS FOR MANUFACTURING SULPHATES OF SODIUM AND POTASSIUM.

A model of the Hargreaves plant is shown, and it exhibits in a clear and instructive manner the arrangement of a piece of chemical apparatus, perhaps as difficult as any to explain the working of by means of plans or diagrams.

The Process.—Common salt mixed with ground rock salt is moulded into oblong cakes and placed in large iron cylinders 18 to 24ft. in diameter and 12ft. deep. Sulphur dioxide from burning pyrites, together with air and steam, is caused to pass *downwards* through the cylinders so charged, in succession, commencing with the strong gas on the most nearly finished sulphate, and is thus absorbed in its passage. At the same time, the common salt during its conversion is evolving hydrochloric acid, which is subsequently condensed and used for manufacturing bleaching powder.

The cylinders are encased in brickwork, and a small fire supplies the heat necessary to maintain the contents of the cylinders at a uniform working temperature. Theoretically, the heat set free during the process should be sufficient to maintain itself and keep the process going. In the best-designed and larger forms of plant, such as that of Messrs. Sullivan & Co., the British Alkali Works, Widnes, this is actually being done, so that once in working order practically no more fuel is required and the small fire-places are simply closed.

JAMES MACTEAR, GLASGOW (*Group XIV. No.* 1467),

Exhibits (1.) Working model of the Mactear carbonating or calcining furnace, with three large diagrams, giving different views of the furnace; (2.) Two large photographs of the mechanical salt-cake furnace; and (3.) Specimens illustrating the Mactear process for recovering sulphur from alkali waste drainage.

A very full description of the mechanical calcining and salt-cake furnaces will be found in this Journal, vol. i. 26 to 32.

MACTEAR PROCESS FOR RECOVERING SULPHUR FROM ALKALI WASTE DRAINAGE.

The drainage liquor, or, as it is termed, "yellow liquor," of the vat waste-heaps, else running into brooks and other water-courses, sewers or drains, and making the first unsightly and unwholesome, and the latter noxious, is treated with a solution of sulphurous acid. The sulphur dioxide obtained from pyrites or from the refuse sulphur of the process, is led into condensing towers built of wood, and bound with iron corner-pieces and tie-rods. Each tower is divided into three stages by means of strong cross-joists, and is then filled with cokes. A tray, with a large number of little tubes of lead covered over with lutes to avoid entrance of air, divides the water into fine streams, and the sulphurous acid gas is then led up one tower, down to the bottom, then up another tower, and so on in succession. The solution of sulphurous acid, in practice, has a specific gravity of only about 2° T. This solution is led, by means of a wooden shoot, to the decomposing vessels, and is mixed on its way with a stream of the yellow liquor; the liquid then runs into the decomposing vessel, where it is met by a stream of hydrochloric acid, and the whole is kept carefully at as near 145° F. as possible. With moderate care little sulphuretted hydrogen is evolved, and the decomposition is regulated by the following method of testing:—A burette being fixed to a wooden upright and filled with the yellow liquor, a sample is drawn from the decomposing vessel, a drop of solution of ferrous sulphate is added, and then the yellow liquor run in from the burette. The number of divisions required to blacken the solution indicates the acid still present.

The sulphur is allowed to settle, and the clear liquor run off through a catch pit, so as to retain any sulphur that might be otherwise lost. After some five or six operations, the sulphur sludge is run off into a drainer. After draining into a stiffish mud, the latter is melted by steam in a suitable vessel, the arsenic being removed by an application of the fact that alkaline sulphides dissolve sulphide of arsenic.

DETAILED COST OF ONE TON OF SULPHUR BY THE "MACTEAR" PROCESS.

	CWT.	QR.	LB.	RATE.	COST.
Pyrites Sulphur	8	0	25	39/-	16·03s.
Salt	35	1	18	16/-	28·33
Vitriol	29	3	27	30/-	45·00
Coal	111	2	7	4½/-	25·20
Repairs	..	..	..	..	4·00
Wages	..	..	..	..	38·50
					157·06
Off Sulphate of Soda	39	0	21	49/-	96·01
Net cost of one ton of Sulphur	..	..	..	..	61·05s.

In the above nothing is charged for hydrochloric acid.

When the "yellow liquors" are very weak, say of specific gravities 5° to 8° T., instead of 11° T., the sulphurous acid solution is replaced by a stronger liquor. This is obtained by preparing a solution of sulphite of calcium in sulphurous acid. The sulphite of calcium is obtained, in a crude form, from old alkali waste-heaps. The oxidised waste is ground with water to a milk, and this is treated with sulphurous acid. More hydrochloric acid is, of course, ultimately required in this latter process.

About 16,000 tons of sulphur have, so far, been made by the Mactear process, as Mr. Mactear informs the writer.

In the exhibit are shown specimens of the hydrochloric acid, of soda waste, and of the clear and perfectly innocuous liquor, free from sulphuretted hydrogen, which is finally run off. Also specimens of sulphur precipitate used for vine dressing, and of rock sulphur obtained by fusion. A bottle contains a mixture of sulphurous acid and "*bog liquor*," as the drainage liquor is termed at St. Rollox, just ready for decomposition, whilst a specimen in another bottle shows the sulphur as precipitated from the mixed liquid by hydrochloric acid.

LUDWIG MOND, LONDON (*Group XIV. No.* 1467)

RECOVERY OF SULPHUR FROM ALKALI WASTE.

There is not the least doubt that this process can be worked even at the present time to profit; in fact, the firm in which Mr. Mond's experiments were first carried out in this country, and for which he first erected plant, still continues the process, and not only utilises its own waste, but some of that from adjoining works. At the first, it was proposed in this process to treat the alkali waste left after lixiviating the black-ash, in the same vats, blowing in air under the false bottoms, so that it should ascend through the superincumbent mass of waste. This did not seem to answer, and separate vats were afterwards constructed for blowing the waste, the latter being carried from the black-ash to the oxidising vats in tram waggons. Even with Mond's process, a final waste is obtained which does still contain sulphur as calcium sulphide to the extent of somewhat under one-fourth of the original total sulphur as sulphide; but, before getting this extracted, the manufacturer is confronted with two questions, the answers to which, in the ordinary course of working, conspire to give a flat negative to the attempt. The one is, What time would be expended in blowing and oxidising this last residual of sulphide so as to render the sulphur available? and, Would it be profitable, with plant and vat space at disposal, to sufficiently protract the oxidising operations, considering the vast bulk of the material dealt with generally, and specially with regard to this final residuum of sulphide? Dr. Schäppi has, however, shown in an able paper (see this Journal, vol. i. 482—486) that by blowing oftener, and by adopting other precautions, considerably more sulphur can be extracted than usually is, and that if the waste after repeated oxidation and lixiviation could be *prevented from hardening*, more sulphur still could be extracted. This is a difficulty that might possibly yet be overcome as the result of further investigation and experiments. The first patents were taken out in 1862 and 1863, and a small pamphlet now before the writer, and published by Mr. Mond in 1868, gives an interesting account of the theoretical and practical bearings of the process. Another pamphlet published by him in 1870, gives an interesting statistical view of the subject, "Of the Probable Effect of the General Adoption in Great Britain of Mond's Process for the Recovery of Sulphur from Alkali Waste from a Mercantile Point of View, being a Paper communicated to the River Pollution Commissioners at their request." At that time and previously, vat waste was carelessly tipped and packed in the waste-heaps, and gave vent to copious noxious emanations, both gaseous and liquid, and on the other hand, much hydrochloric acid was allowed to run away, especially weak acid from the wash-towers. If it will pay *now* to work Mond's process (and the writer was informed by the manager of one firm in Lancashire that the best profit of a recent year of his firm was made by sulphur recovery), it is hard to avoid the conviction that Mr. Mond was not far from the truth *then*, as to realisable actualities, when he stated that "the total cost of manufacturing 40,000 tons of sulphur being £80,000 a-year, a clear profit of £160,000 a-year would then have been obtainable." Mr. Mond's exhibit includes a coloured diagram of plant for lixiviating black-ash, and for the recovery of sulphur from the vat waste. Samples are shown (1) of fresh alkali waste; (2) of spent alkali waste, the residue of the Mond process; (3) of hydrochloric acid, the condensate of the salt-cake process. (4.) The "yellow liquor," containing principally hydrosulphide, polysulphides, and thiosulphate of calcium; (5) precipitated sulphur liquor—*i.e.*, after treatment in the agitator with hydrochloric acid. (6.) Wet and freshly-precipitated sulphur. (7.) The fused and finished sulphur as put in the market.

MESSRS. GASKELL DEACON & CO., WIDNES (*Group XIV. No.* 1467).

The exhibits refer to (1) Deacon's chlorine process with Hurter's improvements, and (2) the manufacture of monohydrated carbonate of sodium, "crystal carbonate," and of bicarbonate of soda by Hurter and Carey's processes.

1. *Deacon's Chlorine Process.*—Excellent coloured diagrams are shown, illustrating a Deacon's chlorine cylinder (superheater and decomposer), with specimens of the baked clay balls saturated with cupric chloride, and a Deacon's shelf bleaching powder chamber, with a specimen of the bleaching powder produced from chlorine which has been generated from hydrochloric acid gas, dried by passing it through the heated cupreous clay balls contained in the Deacon cylinders. With this interesting process, the name of Dr. Ferdinand Hurter is intimately connected. To his admirable paper, "On the Prospects of the Manufacture of Chlorine" (this Journal, vol. ii. 103—109), those specially interested in a study of the question are referred.

2. *Manufacture of Monohydrated Carbonate and Bicarbonate of Soda.*—The investigations and experiments of Hurter have led to the possibility of obtaining in one process what would have previously required at least three to effect, and now in place of the so-called "black salts," as the impure monohydrated carbonate salts, obtained by the evaporation of the black-ash lixivates, are termed, Messrs. Hurter and Carey obtain directly, by evaporation, a pure white crystalline salt, of which Messrs. F. Steiner & Co., the great Turkey-red dyers of Lancashire, declare, "It is the purest form of sodium carbonate in the market," and that, "dissolving readily in water, with a slight evolution of heat, it has thereby an advantage over soda-crystals and soda-ash."

It is well known that the small quantities of iron in soda-ash are derived from cyanides formed in the black-ash process, the nitrogen of these being practically the nitrogen of the coal used in the black-ash mixture, and that on lixiviation in contact with the iron of the vats, ferrocyanides are formed. The monohydrate salts, eventually roasted for the production of soda-ash, retain mother-liquor containing these ferrocyanides, besides some sodium ferrosulphides, and these compounds on roasting decompose, leaving behind ferric oxide. By Hurter and Carey's process, the liquors are first well carbonated by black-ash furnace gases or otherwise. The sulphides in them are also, to a certain extent, oxidised to thiosulphates by the addition of oxidising agents. The silica and alumina in solution are precipitated in the carbonating process, and are separated by settling and subsequently running off the supernatant liquor. By forcing this liquor through a coil of pipe against a loaded valve, the coil being heated by a superheater, so that at least a temperature of 177° C. is attained, the ferrocyanides in presence of the thiosulphates are decomposed with formation of ferrous sulphide, which afterwards is easily separated by allowing the liquors to stand in large settlers. The clear liquors drawn off, on evaporation, yield the pure white "crystal carbonate." See Eng. Pats. 2939, July, 1879; and 608, February, 1880. (This Journal, vol. i. 26—27.)

Ordinary soda-ash roasted in brick furnaces, may contract minute quantities of alumina from the brickwork in addition to that derived from the black-ash mother-liquors, besides containing the small quantities of iron arising from the ferrocyanides, as already mentioned. When soda-ash is used by the dyer or calico-printer, the ash is usually dissolved by steaming in a pan, and is afterwards allowed to settle to deposit any insoluble matters containing iron and alumina, the clear supernatant liquor being eventually used. However, in some cases, the desired settling is not quite effectual, and either iron or alumina in but minute particles on the fibre may, in the case of certain light and bright shades, cause slight but objectionable modifications of colour to develop in spots or patches. It is plain that the crystal carbonate containing absolutely no alumina or iron, is free from the defects named, and furnishes immediately a pure liquor likewise free from the least causticity, a desideratum with woollen bleachers. The following are analyses of "soda-crystals" and of "crystal carbonate":—

	Soda Crystals. %	Crystal Carbonate. %
Carbonate of soda	34·22	82·90
Hydrate of soda	0·10	0·00
Sulphate of soda	2·54	trace
Chloride of sodium	0·27	trace
Water	62·84	17·00
	99·97	99·90
Total soluble impurities (water excepted) on 100 of carbonate	8·21	0·12
Water on 100 of Carbonate	183·64	20·50

SOLUBILITY.—*Soda-crystals* are soluble in cold water with difficulty, because—

1stly. Being in large lumps, they offer but little surface to the action of the water.

2ndly. By solution they *lower* the temperature of the water, *122 units of heat* being *absorbed*.

Crystal Carbonate dissolves in cold water with the greatest ease, because—

1stly. Consisting of minute crystals, it offers immense surface to the action of the water.

2ndly. By solution it *raises* the temperature of the water, *35 units of heat being evolved*.

One ton of crystal carbonate contains as much alkali as 48cwt. of soda-crystals.

STORAGE.—48cwt. of soda-crystals packed in 24 2-cwt. barrels, occupy about 150 cubic feet. One ton of crystal carbonate packed in casks, holding from three to four cwt. each, occupies about 65 cubic feet.

The Bicarbonate of Soda is prepared from the "crystal carbonate" by exposing the latter in an iron revolver, resembling closely a miniature black-ash revolving furnace, to the action of moist carbonic acid gas. Heat is evolved, and the cylinder becomes so hot that were a small quantity of bicarbonate of soda placed in contact with the metal outside, it would suffer slight decomposition. Nevertheless, the bicarbonate formed in the interior of the revolver is not decomposed in the slightest, because of the presence of the surrounding atmosphere of carbonic acid in which it is generated. It goes without saying that the employment of so pure a material as the "crystal carbonate," ensures the production of an extremely pure bicarbonate, and since no water escapes during the process, there is no loss of material carried off in solution, and so the process is one purely of conversion *in situ*.

JAMES MUSPRATT & SONS, WIDNES (*Group XIV. No.* 1467).

MUSPRATT & ESCHELLMANN'S PATENTS FOR MAKING CHLORATE OF POTASSIUM AND CHLORATE OF SODIUM.

(Eng. Pats. 3960, Aug. 15, 1883; 5183 and 5186, Oct. 31, 1883. This Journal, vol. iii. 349 and 445.)

In the patented process, magnesia is substituted for lime for the absorption of chlorine, and subsequent treatment of the liquors obtained, so as to increase the production of chlorate.

Rationale of the Process.—In the ordinary process a large quantity of chlorate of potassium is held in solution by the chloride of calcium of the mother-liquor. $KClO_3$ is much less soluble in magnesium chloride solutions than in those of calcium chloride, and consequently much less chlorate is kept in solution by the magnesium chloride.

The usual proportion of chlorate to chlorides in the liquors obtained by the absorption of chlorine is 1 : 5; but by crystallising out nearly 50 per cent. of the magnesium chloride, before adding the KCl, the quantity of mother-liquor becomes considerably reduced. This, together with the less solubility of $KClO_3$ in the magnesium chloride liquor, increases the production of chlorate in the new process by from 15 to 20 per cent.

The mother-liquor itself (magnesium chloride) is, after proper treatment, for which patents have also been obtained, a valuable by-product.

For the production of chlorate of sodium, the improved liquor containing chlorate and cloride of magnesium is used, in the proportion of about 1 : 3. This liquor is precipitated by carbonate of soda or caustic soda; the filtrate, containing chlorate of sodium and chloride of sodium, is evaporated and the salt separated by fishing; the remaining liquor crystallises, yielding a salt which, after a second crystallisation, is pure chlorate of sodium. The precipitated carbonate of magnesia can be sold as such, or calcined, and the magnesia used over again.

In the Exhibition a diagram is shown, displaying the apparatus used in Muspratt and Eschellmann's process for the manufacture of potassium and sodium chlorates, and, besides this, specimens illustrating the various stages of the processes, as follow:—

1. The improved liquor.
2. The octagon liquor.
3. The neutralised liquor.
4. The chlorate of potassium mother-liquor.
5. Ground potassium chlorate.
6. Potassium chlorate. First crystals of the process
7. Potassium chlorate. Finished crystals.
8. Calcined magnesite, ground.
9. Calcined magnesite (magnesia), unground.
10. Native magnesite in lumps.
11. Magnesium chloride in crystals.
12. Magnesium chloride in crystalline lumps.
    Looked beautifully white and pure.
13. Sodium chlorate. First crystals and greyish.
14. Sodium chlorate. Finished crystals, in size about that of small beans.
    Look very white and pure.

Chlorate of sodium ($NaClO_3$) is largely used for aniline black in calico printing, being far more easily soluble than potassium chlorate.

JOSEPH GAMBLE AND SONS, ST. HELENS (*Group XIV. No.* 1467).

MANUFACTURE OF CHLORATE OF SODIUM.

Messrs. Gamble & Sons employ M. Pechiney's patented process. See this Journal, vol. i. 41.

Specimens are shown of—

1. Barium chlorate ($Ba(ClO_3)_2+H_2O$) Small crystals.
2. " " in medium size crystals; and
3. " " in large crystals.
4. Sodium chlorate, *in fine, medium and large crystals*.

There are exhibited, besides, remarkably fine crystals of sodium sulphide, Na_2S+9H_2O. These are large and transparent, with a faint brownish tinge, and resemble in appearance crystallised sodium acetate. This sodium sulphide is manufactured at Messrs. Gamble's Works, by Schaffner and Helbig's patent process.

[*]Mr. W. Weldon, F.R.S., of Burstow (*Group XIV. No.* 1467).

1. PROCESS FOR MANUFACTURING CHLORINE BY MANGANITE OF CALCIUM.

2. PROCESS FOR MANUFACTURING CHLORINE FROM CHLORIDE OF MAGNESIUM.

Mr. Walter Weldon, F.R.S., exhibits a model of the apparatus employed in the well-known process for the manufacture of chlorine which bears his name, and specimens illustrating the different steps in that process. In 1862, except in a single work, chlorine was universally manufactured by digesting together aqueous hydrochloric acid and ores of manganese; and the residual mixed solution of manganese chloride, ferric chloride, and free hydrochloric acid was always sent into the nearest water-course. The manganese employed in the manufacture of chlorine was thus used only once, and was then thrown away as one of the constituents of a most offensive solution, alike poisonous to fish, and extremely destructive to any masonry or ironwork with which the stream into which it was thrown might come into contact. The problem of how to avoid this loss of the most costly reagent employed in the chlorine manufacture, and at the same time to prevent the nuisance occasioned by that manufacture, had long engaged attention, and the late Mr. Dunlop, of Glasgow, had worked out a process accomplishing these objects, which process was in operation in one factory, that of St. Rollox. The Dunlop process, however, never extended beyond that one factory, and even there, so far as the regeneration of manganese for use again in the manufacture of chlorine is concerned, it is now replaced by the Weldon process, though it is still employed for the production of an artificial oxide of manganese for use by glass-makers and others. Mr. Weldon took up the problem of the regeneration of MnO_2 from $MnCl_2$ in 1866. Chlorine began to be manufactured by means of "Weldon mud" about 1870, and it is now years since an ounce of manganese ore was anywhere employed in the manufacture of chlorine, except to make up unavoidable mechanical loss in the Weldon process. There is no other instance of the old-established methods of a great chemical industry having been completely revolutionised within so brief a period. There are four works in this country and two on the Continent in which chlorine is manufactured by the Deacon process. In the four English works, the two-thirds or so of the HCl treated by the Deacon process, which escapes decomposition in that process, is subsequently treated by the Weldon process. In the two Continental works in question, that HCl is condensed into aqueous acid for sale, and those two works are the only chlorine works in the world in which the Weldon process is not employed.

The residual products of the manufacture of chlorine by the Weldon process is a mixed solution of manganese chloride and calcium chloride, containing also a little free hydrochloric acid. The latter having been neutralised by limestone, milk of lime is added to the neutralised liquor in such quantity that the product is a solution of calcium chloride holding in suspension manganese hydrate and calcium hydrate, in the proportion of one equivalent of the former to six-tenths of an equivalent of the latter. Into this mixture, which is a thin white mud, air is then injected, until about 80 per cent. of the manganese present has become converted into MnO_2. The absorption of oxygen from the injected air takes place very rapidly; in large "oxidisers," as the vessels in which the operation is performed are called, more than a hundredweight of oxygen being absorbed per hour. The product is a thin black mud, in which four-tenths of the manganese present is in the state of $MnMnO_3$, and six-tenths of it in that of $CaMnO_3$, or a compound of MnO_2 with CaO. It is upon the formation of this compound that the Weldon process depends. When manganese hydrate is treated by oxygen in the wet way, the MnO_2 which forms must combine with a base at the moment of its formation. If the only base present be manganous hydrate, the MnO_2 formed by the combination with oxygen of a portion of the hydrated MnO combines with the other portion of that MnO, forming either normal manganite of manganese, $MnMnO_3$, being a compound of one of MnO_2 with one of MnO, or Mn_3O_4, being a compound of one of MnO_2 with two of MnO, according to the temperature employed. Thus, when MnO is the only protoxide present, one-half is the maximum proportion of it which can be converted into MnO_2, the other half of the MnO being required to furnish the necessary base for that MnO_2 to combine with. If, however, with the manganous hydrate which is treated by oxygen in the wet way any one of a certain number of soluble protoxides be present, the MnO_2 which forms combines with that soluble protoxide instead of combining with MnO; and thus, if the quantity of soluble protoxide present be a full equivalent, the whole of the manganese present may be converted into MnO_2. But to convert the whole of the manganous hydrate treated, into MnO_2 combined with CaO, would of itself have no advantage to the manufacturer of chlorine, over the conversion of only half of it into MnO_2, the half of it converted into MnO_2 being combined with the other half of it as $MnMnO_3$: since calcium manganate liberates from hydrochloric acid only the same proportion of its chlorine as is liberated therefrom by manganese manganite, as is seen from the two equations—

$$MnMnO_3 + 6HCl = 2MnCl_2 + 3H_2O + 2Cl \text{ ; and}$$
$$CaMnO_3 + 6HCl = CaCl_2 + MnCl_2 + 3H_2O + 2Cl.$$

The advantage of forming calcium manganite instead of manganese manganite lies chiefly in this, that the absorption of oxygen by manganous hydrate, in the presence of dissolved lime, is enormously more rapid than the absorption of oxygen by manganous hydrate in the absence of a soluble base. To such an extent is this the case, that while, per given quantity of MnO_2 in each respectively, Weldon mud is very much cheaper than native manganese, the product of the treatment by oxygen of manganese hydrate only, would be very much more costly than native manganese.

To convert into calcium manganite the whole of the manganous hydrate treated, would require the presence therewith of a full equivalent of calcium hydrate; but so large a proportion of calcium hydrate cannot be employed industrially, because there cannot be present sufficient calcium chloride to hold it in solution. Hence, only enough calcium hydrate is used to convert 0·6 of the manganese present into manganite of calcium. The other 0·4 of the manganese present is converted into manganite of manganese.

When 60 per cent. of the manganese present in a Weldon oxidiser has been converted into $CaMnO_3$, and the other 40 per cent. of it into $MnMnO_3$, a further quantity of neutral solution of $MnCl_2$ and $CaCl_2$ is sent into the oxidiser, and the injection of air is continued. At the temperature employed $MnCl_2$ can react upon half the lime of normal calcium manganite, the products being manganous hydrate and a compound of two of MnO_2 with one of CaO. The manganous hydrate becomes oxidised, partly into $MnMnO_3$, partly into Mn_3O_4, the final product being a thin black mud consisting of solution of calcium chloride *holding in suspension a mixture of* manganites of manganese with an acid manganite of calcium, which mixture can liberate more than two equivalents of chlorine from six of HCl. This product is then run into settlers, in which it separates into clear solution of calcium chloride and a denser mud. The former is then decanted, and the latter run into stone stills which have previously been charged with aqueous hydrochloric acid.

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[*] The following account was forwarded to the writer of this report by Mr. Weldon two or three months ago. It is printed word for word as written in the manuscript, in accordance with a wish expressed in a letter received at the same time from Mr. Weldon. It is somewhat remarkable that this the last contribution from his pen for this Journal, is the account of the great work of his life—written with characteristic care, and in that inimitable style peculiar to him whether writing or speaking, which rivets the attention alike of reader and hearer. It is very remarkable that it should be timed to appear in that number of this Journal which also contains the brief notice that his life's work is done.

While this process has completely superseded the old method of manufacturing chlorine, and, as Dumas put it, has "cheapened every sheet of paper and every yard of calico used in the world," saving to the community hundreds of thousands of pounds per annum, besides enabling the manufacture of chlorine to be carried on without causing nuisance, and ameliorating the lot of the workmen engaged in that manufacture, who have now simply to manipulate a few cocks and valves, its inventor believes that it is about itself to be superseded. He exhibits also some illustrations of a process for the manufacture of chlorine, which is performed in the dry way, in which manganese is not employed, and which, while it is applicable to the manufacture of chlorine from the hydrochloric acid produced in the Leblanc process, may also prove capable of enabling chlorine to be manufactured in connection with the manufacture of soda by the ammonia process. At present the ammonium chloride of the ammonia-soda process is decomposed by lime, and the chlorine of the salt decomposed by that process is thus finally obtained as calcium chloride, and in that state is thrown away. In 1872 M. Solvay and Mr. Weldon simultaneously proposed to decompose that ammonium chloride by magnesia instead of by lime, and to treat the resulting magnesium chloride for the obtainment of its chlorine as hydrochloric acid. [*] Neither M. Solvay nor Mr. Weldon, however, succeeded in rendering the decomposition of NH_4Cl by MgO industrially practicable; and it is only quite recently that it has been rendered so by MM. Pechiney & Co., Salindres. Moreover, the manipulation of large quantities of magnesium chloride was found to present great difficulties, which for many years seemed insuperable. Mr. Weldon's continuous experiments on the subject at length led him to the idea of converting the magnesium chloride into solid infusible oxychloride, before attempting to drive off its chlorine as HCl; and it was then found that if the oxychloride were heated in a current of air, a large part of its chlorine was evolved in the free state. Mr. Weldon failed to devise apparatus in which this operation could be conducted industrially, but suitable apparatus for it has now been invented by M. Pechiney, in conjunction with the engineer of Salindres, M. Boulouvard. As this apparatus is not exhibited, it need not be here described.

The starting point of the new Weldon chlorine process is magnesium chloride, which may be obtained either by neutralising aqueous hydrochloric acid by magnesia, or by decomposing by magnesia the ammonium chloride of the ammonia-soda process, or may be magnesium chloride from any other source. To a hot saturated solution of it free magnesia is added, and there is thus obtained a solid hydrated oxychloride, containing six equivalents of water. This is heated to a low temperature, until a large part of its water has been driven off. The residue is then heated to a high temperature in a current of air, when *half its chlorine goes off in the free state*, and half as vapour of HCl, magnesia only remaining behind. The proportion of the chlorine of the oxychloride which goes of in the free state is thus 50 per cent. greater than the proportion of free chlorine obtained by the old Weldon process from an equivalent quantity of hydrochloric acid, and that part of it which does not go off in the free state, instead of being lost as $CaCl_2$ is yielded as HCl, available either as raw material from which to manufacture more chlorine, or for use for any other purpose. The development of this process will be watched with great interest, since its success, by enabling the chlorine of the salt used in the manufacture of ammonia soda to be obtained in the free state, would take away from the Leblanc process its only remaining support.

Messrs. Brunner, Mond & Co., Limited (*Group XIV. No.* 1467).

THE AMMONIA-SODA PROCESS (SOLVAY AND MOND).

This firm exhibits a large photo-lithographed picture of the Winnington Works, near Northwich.

Moreover, specimens are shown illustrating the different steps in the ammonia-soda process—viz.:—

(1.) The natural brine.

(2.) Ammoniacal brine before carbonating under pressure.

(3.) Carbonated ammoniacal brine.

(4.) Crude bicarbonate of soda.

(5.) Sesquicarbonate of soda.

(6.) Refined bicarbonate of soda (Mond and Jarmay's process. Eng. Pat. 2996, February 9, 1884. This Journal, iv. 282).

(7.) Monocarbonate of soda.

(8.) Pure alkali (unground).

(9.) Pure alkali (ground).

Messrs. Brunner, Mond & Co.'s Works were established in 1873, and are now producing 7000 tons of carbonate of soda per month. The extension of the works now in progress will raise their producing power to 10,000 tons per month.

The patents of Mr. Ernest Solvay, of Brussels, are being worked by this firm, together with various improvements patented by Mr. Ludwig Mond.

Although the chemistry of the ammonia-soda process was fully described in a patent taken out in England in 1838 by[†] Messrs. Dyar and Hemming, and although several practical manufacturers of the highest standing, amongst others, James Muspratt, James Young, William Gossage, and Henry Deacon, had devoted time, energy, and capital to its realisation, it was considered incapable to compete with its rival the Leblanc process, until Mr. Ernest Solvay made it an industrial success, by the apparatus which he invented, and the indomitable energy and perseverance with which he worked out the details of the process. Mr. E. Solvay is therefore justly considered the founder of the ammonia-soda industry.

Mr. Ludwig Mond took a license from Mr. Solvay in 1872, which was subsequently transferred to Messrs. Brunner, Mond & Co. At that time the works which Mr. Solvay had established at Couillet, in Belgium, produced about ten tons of carbonate of soda per diem in two separate sheds. Under Mr. Solvay's guidance Mr. Mond designed plans for carrying out Mr. Solvay's process on a larger scale, according to which works were erected in Winnington in 1873. These works proved capable of producing 20 tons per diem, per element of plant. They were started early in 1874, and were the first works in which carbonate of soda was manufactured from natural brine.

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[*] In that last letter received by the writer from Mr. Weldon, and *accompanying this communication*, he states:—"*Except* that I could not but take the opportunity of making some explanations of some points in respect of the old Weldon process which are frequently misunderstood, the only part of the enclosed which I really care about is that part of it which gives to M. Pechiney and M. Boulouvard the credit due to them in respect of the new chlorine process."

[†] "The Manufacture of Carbonate of Soda." Harrison Grey Dyar and John Hemming. Eng. Pat. 7713, June 30, 1838.

When in 1881 it was decided considerably to extend the works at Winnington, Mr. Mond designed plant upon a much larger scale. Some of the apparatus used was increased in size, but a great part of the plant was constructed according to Mr. Mond's own patents, and entirely different from that hitherto in use.

Each element of this plant produces 60 tons of carbonate of soda per diem, and thus effects a great saving in labour, repairs, and first cost, as compared with the older plant.

Messrs. Brunner, Mond & Co. also exhibit refined bicarbonate, made by Mond and Jarmay's process.

The bicarbonate made by the ammonia-soda process contains a certain quantity of ammonia which cannot be got rid of by washing, and makes the product unsuitable for the market. Messrs. Mond and Jarmay dissolve this bicarbonate in warm water and pass the clarified solution in a constant stream through a series of cooling tanks. In these a pure bicarbonate of soda is deposited in small crystals. These are from time to time removed, passed through a hydro-extractor, then dried and dressed as usual.

All the ammonia remains in the mother-liquor, which is used many times over, and is then treated for the recovery of the ammonia.

MESSRS. BELL BROS., LIMITED, MIDDLESBROUGH (*Group XIV. No.* 1467).

THE AMMONIA-SODA PROCESS (SCHLOESING).

The patents worked by Messrs. Bell Bros. were taken out by Sidney Pitt (communications from J. J. T. Schloesing) on May 28, 1878, and May 4, 1882, entitled, "Improvements in the Manufacture of Carbonate of Soda by the Ammonia Process," and numbered respectively 2130 and 2110.

The essential difference between Solvay's and Schloesing's processes is that in the former, ammonia and brine are treated together with carbonic acid under pressure; whilst in the latter ammonia is carbonated as *one separate step* of the entire process, and the small crystals of bicarbonate of ammonia precipitating are used in a *second step* to mix with brine in an agitating vessel, so as to yield bicarbonate of soda.

Messrs. Bell Bros., Limited, exhibit the following specimens:—

(1.) The bicarbonate of ammonia representing the first step of the process.

(2.) The bicarbonate of soda produced by mixing the ammoniacal salt with brine, and

(3.) The finished product.

Messrs. Bell Bros. have only somewhat recently started, and they are now manufacturing about 200 tons of alkali per month.

For a full account of the origin of the ammonia-soda process, see Mr. Mond's interesting paper commencing on this page.

THE EGLINTON CHEMICAL CO., LIMITED, GLASGOW (*Group XIV. No.* 1441).

The manufactures of this firm are represented by the following exhibits:—

(1.) *Chromate Leather*, tanned with bichromate of potash, etc.; produced in one-fifth the time of ordinary tanned leather, and at less than half the cost. It is said to be much more durable than ordinary leather, and thoroughly waterproof. Suitable for all purposes of the ordinary article, and particularly for use in the army and navy, for shooting, fishing, and football boots, hydraulic and pump leather, and for buffing purposes.

(2.) *Patent Bichromate of Soda*, as a substitute for bichromate of potash, containing as much chromic acid as bichromate of potash, and saleable at about £10 per ton under the price of bichromate of potash. Samples of chromate and bichromate of lime and of alumina are also exhibited.

(3.) *Silica Bricks*, made from pure flint. Practically free from iron; more refractory and less expansive under intense heat than Welsh Dinas bricks, or any other form of silica brick. Specially suited for lining steel and iron heating furnaces, arches of gas retorts, etc., etc.

(To be continued.)

Communication.

ON THE ORIGIN OF THE AMMONIA-SODA PROCESS.

BY LUDWIG MOND.

ALL writers on this subject from Brande in 1841[*] to Lunge[†] in 1880, fix the date of this invention at the 30th of June, 1838, when Messrs. Harrison Grey Dyar and John Hemming, both chemists of London, filed the petition for their English patent. Only of recent years an attempt has been made by several French savants[‡] to put the date of the invention sixteen years later, in order to claim it as a French invention and to give the credit of it to two of their countrymen, Messrs. Schloesing and Rolland, who took out a patent relating to the subject in 1858, preceded by a patent taken out by Mr. Schloesing alone in 1854.

It would seem superfluous to contradict an error so palpable and so easily refuted by reference to documents accessible to everyone, had not this statement been made by three scientific men of the highest standing, whose name is sufficient to obtain acceptance for it by numbers who have not themselves inquired into the facts.

In justice to Messrs. Schloesing and Rolland, I must state that these gentlemen in their various publications have fully acknowledged that the process they endeavoured to improve had been invented long ago, and that the various chemical operations constituting the process had been described so exactly in a patent taken out in France by Delaunay as to leave to future inventors very little to do.

On referring to Delaunay's patent, dated 27th of May, 1839, this will be found an exact translation of the English specification of Messrs. Dyar and Hemming, of October, 1838, whence it is clear that Delaunay was simply the agent of Messrs. Dyar and Hemming. Inquiring further into this French specification we come, however, upon a remarkable and important fact which has hitherto been left unnoticed. This patent is followed on the 18th of May, 1840, by an additional patent, a facility enjoyed under the French patent law almost free of expense, which has evidently in this instance led the inventors to protect in France most important improvements found out shortly after taking out their original patent, while the high cost of a second English patent has prevented their doing the same in England.

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[*] Brande: Manual of Chemistry, 5th edition, pp. 661.

[†] Lunge: Manufacture of Sulphuric Acid and Alkali, viii. p. 1.

[‡] Frémy: Presidential Address to the French Association for the Advancement of Science, 1878. Bouley: Président de l'Académie des Sciences; *Comptes Rendus*, T.C. No. 14. Scheurer Kestner: Conférence à la Société d'Encouragement sur Nicolas Leblanc, 28 Mars, 1885.